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THE

CARPENTER'S AND JOINER'S

POCKET COMPANION.

——CONSISTING OF——

THE MOST USEFUL RULES AND MEMORANDAS, COLLECTED FROM SOME OF THE BEST ARCHITECTURAL WORKS OF THE DAY, AND PRACTICALLY TESTED BY MANY YEARS' EXPERIENCE IN THE

SHOP, FACTORY AND BUILDING.

——ALSO——

A TREATISE ON THE

FRAMING SQUARE.

BY THOMAS MOLONEY,
CARPENTER AND JOINER.

JACKSON, MICH.

1878.

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ERRATA.

Page 12, first line, for A C B, read A T B.
" " second line, for B F, read B T.
" 13, third line, for B F, read B E.

PREFACE

In offering this little volume to the Building Fraternity, the Author seeks to supply a vacancy in Architectural literature, viz: a cheap, and small work containing, in a condensed form, the most practical rules to be found in many of the more costly books.

The works of Nicholson, Benjamin Haviland, Sloan and Hatfield have been freely consulted, and many valuable items selected from them.

Some of the Tables and memorandas are taken from VOGDES' ARCHITECTS' COMPANION—the name of the Author being proof of their accuracy.

The parts relating to the uses of the PROTRACTOR, PLAIN SCALE, SLIDE RULE, COMPASS and SQUARE, have been thoroughly tested by practical applications.

The aplication of the Framing-Square in getting lengths, bevels, pitches, miters &c. for all square, bevelled or raking work has been used personally for several years and obviates the necessity of using as many lines as is often done in laying out

roofs containing Hips, Jacks. Valleys &c. Many of our most valuable "CARPENTER'S ASSISTANT'S" are large works.— very good to study and commit to memory. — but are often of no account as a 'Companion', being either 'at home in the Bureau' or at the Shop in the Chest. when the need'ful information is wanted on an outside jol.

To those who want a book for daily refference, this little volume is offered, hoping that it may prove of practical utility to all who are interested in the Building trade

T. M.

THE

CARPENTER,S AND JOINER,S

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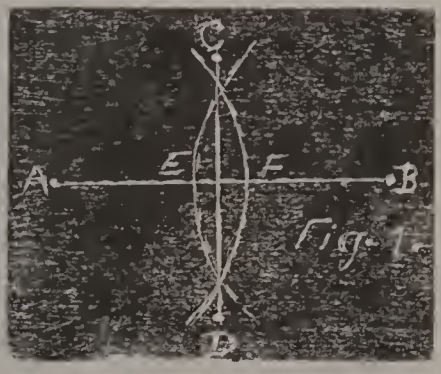
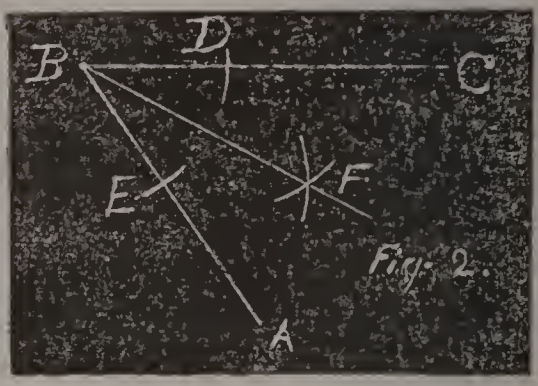
Practical Geometry

To Bisect a given Line, A B, FIG. 1.



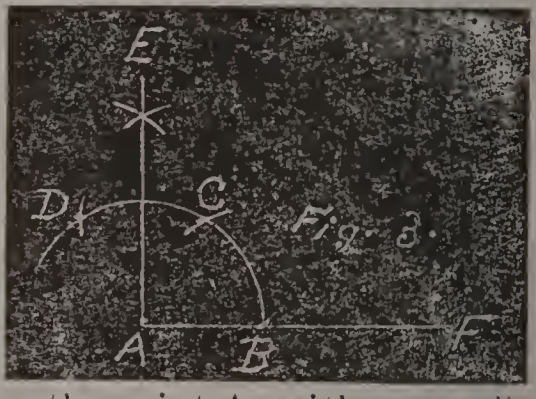
With A and B as centers, with any Radius greater than one half A B, draw ares C E D and C F D, and through the points of intersection draw C D.

To bisect a given Angle A B C. FIG. 2



From B as a center, with any radius, describe arcs cutting the sides at D and E; from these two points as centers, with the same or any other radius, draw arcs cutting each other at F. Draw B F.

To erect a Perpendicular at, or near the end of a given Line A F. FIG. 3.



From the point A, with any radius, describe the arc B C D, From B, with the same radius, cross at C; and from C, cross at D; then from C and D cross at E.

THE CIRCLE. FIG. 4.

The boundary or margin of a Circle is called the CIRCUMFERENCE; the line A B the DIAMETER; the line A O the RADIUS; a line connecting the extremities of an arc as E V, is called the CHORD of the arc or segment E T V. The line T D bisecting the chord, is the VERSED SINE. the line T H touching the circumference, and perpendicular to the radius is called the TANGENT. The space enclosed between an arc and the two radii is a SECTOR, as T V O.

A line drawn perpendicular from the center of the Chord of any arc will give the Diameter; and if we draw lines from the centers of any two Chords, the intersection of those lines will be the center of the circle.

A SECANT is a line, O H, that cuts a circle, lying partly inside and partly outside of the circle.

A Semi-circle, A C B, is one half of the circumference. A Quadrant, B F, Is one quarter of the circumference.

A Sphere is a solid with a continued curved surface, equally distant at every point from the center.

A Spheroid is a solid like a sphere, but not exactly round, one diameter being longer than the other.

NOTE.—The terms diameter, radius, segment, &c. apply to spheres and spheroids the same as they do to plane surfaces.

An ELLIPSE is the section of a cone or cylinder cut by a plane passing obliquely through both sides.

A CONE is a solid having a circle for a base, and tapering to a point or vertex.

Conic sections are the figures made by a plane cutting a cone.

A PARABOLA is the section of a cone cut by a plane parallel to its side.

A HYPERBOLA is the section of a cone cut by a plane at a greater angle through the base than is made by the side of the cone.

A Cylinder is a solid having equal and parallel circles for its ends, and would be generated by the revolution of a rectangle about one of its sides.

A CONOID is a solid generated by revolving a parabola or hyperbola on its axis.

An ARC is any part of a circle, as B F.

The BASE of any figure is that side upon which it is supposed to stand, and the altitude or height is the perpendicular falling upon that base from the opposite angle.

The PERIMETER of any figure is the sum of all its sides taken together.

In the ELLIPSE, the longest diameter is called the TRANSVERSE axis. The shortest diameter is called the CONJUGATE axis.

An ORDINATE is a line drawn from any point in the circumference parallel with one of the diameters.

To draw an ELLIPSE with a string.

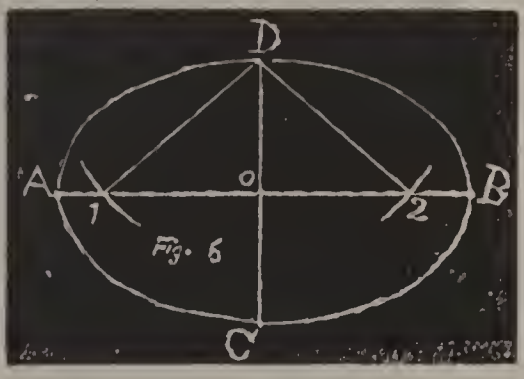


Fig. 5

Let A B, FIG. 5, equal the transverse axis, and C D the conjugate. Set the Dividers from A to O, and with the same

extent, from D as a center, cross the longest diameter near each end at 1 and 2.

Stick a brad awl at 1, another at 2, and one at D; tie a string tight around them and then pull out the awl at D; place a pencil inside the string, and by working it around, keeping the string tight, a very good Ellipse can be drawn.

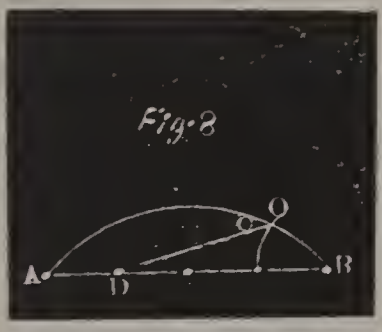
To strike an arc or segment through any three given points.

Let A H O FIG. 6, be the three points, with any radius less than the least distance between either of the points, and with each of the three points as centers, describe arcs crossing each other, and through the points of intersection draw lines intersecting at D, which will be the center to strike from, by taking the distance to any of the points as a radius.

To inscribe a Circle in any Triangle.

Bisect two angles, (See FIG. 2, page 10) as A and B, FIG. 7 ; then the intersection of the lines at O will be the center of the circle, and D O the radius.

To find the length of any part of a circle.



Divide the chord A B, into four parts; with one part as a radius cut the arc at O

draw O D which will be as near one half the length of the arc A O B as can be drawn by any other method.

To get the length of a Quarter Circle.

Add together the CHORD and VERSED SINE. (See page 11.)

To describe an Elliptic Arch.

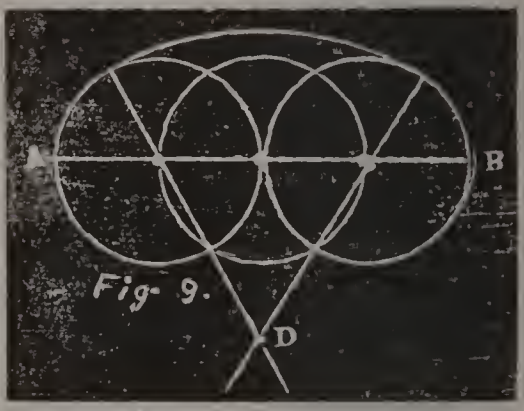


Fig. 9.

Divide the Chord A B, FIG. 9, into four equal parts; with each point of division for a center, and each part as a radius, describe three circles cutting each other in centers. Through the intersection of the outside points draw lines crossing at D which will be the center for striking the flat part, or top of Arch.

A full Ellipse can be drawn by drawing two more lines intersecting opposite D for another center.

To draw Lines leading to — or from— the Circumference of a Circular Arc, and tending toward the Center, when the Center is inaccessible.

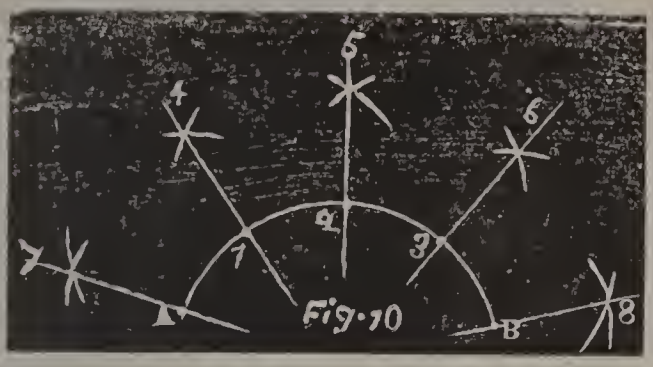


Fig. 10

Divide the Arc into the required number of equal parts. Then with any radius less than two of these parts, describe arcs cutting each other as follows:—

From A and 2 as centers cross at 4; from 1 and 3, cross at 5; from 2 and B cross at 6. Then draw 1 4, 2 5, and 3 6.

To draw the End Lines, as at A and B

With the same radius, and from 1 and 3 as centers draw Arcs at 7 and 8; then with the radius 1 4, from A and B as centers, cross at 7 and 8. Draw 7 A and 8 B.

The Radius of a Circle will go just six times around it.

To "Saw-kerf" Boards, Moldings, &c. to bend around a Circular opening.

Fig. 11.

Let A E B, FIG. 11, represent a Circular opening, and O B a board to be bent on the outside of this circle.

Make one cut in the board (or any piece of the same thickness) to the required depth, and with the same saw to be used in making all the cuts. Now place the side of the board even with the diameter of the circle, and the saw-kerf at the center at O. From B set up the perpendicular B H; stick a brad-awl or nail at each side of the piece, as at 1 and 3, so as to keep this end stationary; then spring the piece slowly until the cut at O is just closed, and make a mark on the line H, where the face of the board comes to. This will be the distance between the saw-kerfs.

Care must be taken so that the piece be

kept perfectly straight at each side of the saw-kerf while springing, else it is evident too great a space will be obtained.

To bend a piece on the inside of a circle deduct twice the thickness of the material from the width of the opening, and proceed as above.

NOTE.—It is not necessary to lay out the Circle or Segment in full; just draw a line on any board, setting up a Perpendicular near one end, and let the distance from the saw-kerf to this perpendicular line be equal to the Radius.

To get the distances for bending stuff around an Elliptic form; first find the two nearest radii—getting the space from each radius separately. (See FIG. 6, page 14,for for finding the radius of an arc.)

When it is desired to have a smooth surface on the face of panels or other work to be bent, a better, but more expensive way is, to "dado" the stuff on the back to one-quarter of an inch, or less, of the face; the distance between the gains may be equal to the size of the dado. The board is then fastened around a "form" of the desired shape, and keys fitted and glued into the gains until the piece fits the form true.

In making circular Soffits, such as Heads for Window frames, Door frames &c. it

is cheaper to build up the circle out of one or more thickness of plank sawed to the proper shape. Sometimes these pieces are nailed together in the rough, and then veneered with some very thin boards.

To get the Stretchout of a Circle.

Multiply the Diameter by the Decimal term 3.1416 (or to be still more exact, by 3.1415926) and the product will be the circumference of the whole circle.

The term, 3.1416 is the one generally used, being near enough to work to.

To Describe a Circle that will be equal to two given Circles.

Construct a Triangle, making the two Diameters of the given Circles two of the sides, forming a Right Angle. On the HYPOTHENUSE of this TRIANGLE for a Diameter, describe a Circle, the AREA of which will be equal to the other two.

A Square may be formed in the same manner equal to two other Squares, by making the BASE and PERPENDICULAR

each equal to one of the sides of the two given Squares, and then constructing another Square on the HYPOTHENUSE,

Angles, Polygons, &c.

An ANGLE is the opening between two lines, meeting at a point, and is called a RIGHT ANGLE, when the two lines are perpendicular to each other; an ACUTE ANGLE, when it is less or sharper than a right angle; and OBTUSE, when it is greater than a right angle.

A TRIANGLE is a figure of three sides, and is called EQUILATERAL, when all its sides are equal; ISOSCELES, when TWO of its sides are equal; and SCALENE, when all the sides are unequal.

EQUILATERAL triangles are also equiangular. Isosceles Triangles have two equal angles, as well as two equal sides; and scaline triangles have the angles as well as the sides unequal.

A QUADRILATERAL or QUADRANGLE is a figure of four sides, and when the four sides are all equal, and the angles are all RIGHT ANGLES, it is called a SQUARE; when the opposite sides are parallel and equal, it is called a PARALLELOGRAM.

When the sides are all equal, but the angles not right angles, it is termed a Rhombus; when the opposite sides are equal, and the angles all right angles, it is termed a RECTANGLE; when the opposite sides are equal and parallel, but the angles are not right angles, it is called a RHOMBOID; if all the sides are unequal, it is a TRAPEZIUM; and when only one pair of opposite sides are parallel, it is a TRAPEZOID.

All plane figures having more than four sides are termed POLYGONS; and are called regular, when the sides and angles are all equal; and irregular, when they are not equal. They are named according to the number of their sides and angles, viz:

A figure of five sides is called a pentagon.
A do. " six " " a hexagon.
A do. " seven " " a heptagon.
A do. " eight " " an octagon.
A do. " nine " " a nonagon.
A do. " ten " " a decagon.
A do. " eleven " " a undecagon.
A do. " twelve " " a dodecagon.

NOTE.— A triangle is sometimes called a TRIGON, and a square a TETRAGON.

The Hypothenuse of a triangle is the side opposite the right angle.

A PRISM is a solid of three or more sides whose ends are equal, similar, and parallel, and whose sides are parallelograms.

A CUBE is a right prism having *six* equal *square* faces, all its angles *right angles*, and its opposite faces parallel.

A PARALLELOPIPEDON is a prism having *six* quadrilateral faces or planes, the opposite pairs being equal and parallel.

A PYRAMID is a solid whose sides are all triangles, meeting at a common point called the *vertex* or *summit*, and whose base is a rectilinear figure, as a TRIANGLE, SQUARE, or POLYGON, and from the shape of which the pyramid is named as PENTAGONAL, OCTAGONAL, &c.

A *Segment* of a pyramid is a part cut off by a plane parallel to the base. A *frustum* or *trunk* of a pyramid is the portion remaining after a part has been cut off parallel to the base.

A *Prismoid* is a solid having parallel ends or bases, dissimilar in shape, with quadrilateral sides.

A *Wedge* is a solid of five sides, of which two are *rhomboidal*, meeting at a common line or edge with a *rectangular* base, and *triangular* ends.

To lay out an Octagon with A Framing Square.

Suppose you have a stick of timber any size — from 1 inch to 24 inches square; lay the blade of the Square across one of the sides diagonally, so that the whole length of the blade will be on the stick, and the outside corners even with the opposite sides; make a mark at 7, and another at 17; set a *Gauge* to *either* of these points for taking off the corners.

To describe an Octagon with the Compasses.

First form a *Square* of the required dimensions; draw diagonals from each corner crossing each other at the center; set one leg of the Compasses at one corner of the square, and extend the other leg to the intersection of the diagonals at the center.

With this *radius*, and from each corner as a center, describe arcs cutting the sides of the square; draw lines across the corners from where the arcs cuts the sides.

In getting out large *beads* or *half-rounds* 'by hand', it is better to form them into *octagons* first.

Mensuration of Surfaces.

1. *To find the area of a square, rectangle, rhombus or rhomboid.*

Rule.—Multiply the length by the perpendicular height or breadth, and the product will be the area.

2. *To find the area of a triangle.*

Rule.—Multiply the base by half the perpendicular height, and the product will be the area.

Or, from *half the sum* of the three sides *subtract* each side separately; then multiply the half sum and the three remainders continually together, and the square root of the product will be the required area.

3. *To find the hypothenuse of a right-angled triangle.*

Rule.—Add together the *squares* of the *two sides*, and the *square root* of the sum will be the length of the hypothenuse.

NOTE.—By this *rule* the length of Rafters can be obtained, calling the Rafter the hypothenuse of the triangle; the rise, and half-width of Building, the two sides.

4. *To find the length of one of the legs when the hypothenuse and other leg is known.*

Rule.—Subtract the square of the known leg from the square of the hypothenuse, and the square root of the remainder will be the length of the other leg.

5. *The area and base of any triangle being known, to find the perpendicular height.*

Rule.—Divide double the area by the base, and the quotient will be the perpendicular height.

Or, divide double the area by the height and the quotient will be the base.

6. *The base and perpendicular of any plane triangle being known, to find the side of its inscribed square.*

Rule.—Divide the product of the base and perpendicular by their sum, and the quotient will be the side of its inscribed square.

7. *To find the area of a trapezium.*

Rule.—Multiply either diagonal by half the sum of the two perpendiculars falling upon it, and the product will be the area.

8. *To find the area of any regular polygon.*

Rule.—Multiply half the perimeter by the perpendicular falling from its center upon either one of its sides, and the product will be the area.

9. *To find the area of a trapezoid.*

Rule.—Multiply half the sum of the parallel sides by the perpendicular height between them; the product will be the area.

10. *To find the areas of irregular polygons.*

Rule.—Draw diagonals to divide the figures into trapeziums and triangles; find the area of each separately, and the sum of the whole will be the required area.

11. *To find the area of a ring:* that is, the space enclosed between the circumferences of two circles, having a common center.

Rule.—Square the diameter of each ring, and subtract the square of the less from the square of the greater. Multiply the difference of the squares by the decimal term .7854; the product will be the area.

12 *To find the area of any regular polygon*, when the side only is known.

Rule.—Multiply the square of the side by the multiplier opposite to the name of the polygon in the following table, and the product will be the area.

TABLE

OF THE ANGLES, &c. OF POLYGONS.

No. of sides.	*Name of Polygon*	*Angle.*	*Angle of Polygon.*	*Area, or Multipliers.*
3	Triangle.	120 ○	60 ○	0.433012
4	Square.	90	90	1.
5	Pentagon.	72	108	1.720477
6	Hexagon.	60	120	2.598076
7	Heptagon.	51⅜	128⅝	3.633912
8	Octagon.	45	135	4.828427
9	Nonagon.	40	140	6.181824
10	Decagon.	36	144	7.694208
11	Undecagon.	32¼	147¾	9.365640
12	Dodecagon.	30	150	11.196152

Additional use of this Table.

The third and fourth columns of this table will be found useful in the construction of those figures with the aid of the Sector or Plane Scale. Thus, if it is desired to describe an Octagon, opposite to

it, in the third column, is 45: that is, the side of an octagon forms an angle of 45 degrees with a line extended outward from either of the other sides.

On both the Sector, and Plain Scale, there is laid down a scale of CHORDS numbered from 1 to 90,marked—C H O; to lay out an octagon with this Scale, first draw a *base line* to start from; set the compasses from 1 to 60 and describe a part of a circle, using any point on this line for a center, one end of the arc also being on the line; then take the distance from 1 to 45, place one foot of the compasses at the end of the arc resting on the base line, and describe another arc crossing the first one; draw a line from this point to the first center used, and you will have *two* sides of the octagon.

The length of those sides can then be laid out, and, having the angle, the other sides can be readily drawn.

The fourth column gives the angle that any two adjoining sides of the different figures make with each other.

Arcs, Segments, Circles, Zones &c.

1. The diameter of the circle, and versed sine of any arc being known, then, double the square root of the product of the difference between the diameter and versed sine multiplied by the versed sine, will equal the *chord*.

2. The square root of the sum of the squares of half the chord and of the versed sine equals the chord of half the arc.

Or, the square root of the diameter multiplied by the versed sine, equals the chord of half the arc.

3. *To find the versed sine.*

Rule.—Subtract the square of the chord from the square of the diameter, and extract the square root of the remainder; deduct this root from the diameter, and one-half of the remainder will equal the versed sine.

Or, from the square of the chord of half the arc, deduct the square of half the chord of the arc, and the square root of the remainder will equal the versed sine.

Or, divide the square of the chord of half the arc by the diameter, and the quotient will be the versed sine.

4. *To find the diameter.*

Rule.—Add together the square of the versed sine and the square of half the chord of the arc, and then divide the sum by the versed sine.

Or, divide the square of the chord of half the arc by the versed sine.

NOTE.—By this *rule* we can readily determine the length of rod, or distance between tram-points for describing circular segments. The *rule* gives the *diameter* of the circle, of which the arc is a portion.

The difference between *half the chord* of the arc, and, *the chord of half* the arc is this: the first is one-half the width of the opening at the spring of the arch; while the second is a line drawn from the highest point of the arc at the center, to either of its ends at the springing point.

5. *To find the length of an arc.*

When the number of degrees it contains, or the radius, chord and versed sine are known.

Rule.—Multiply the number of degrees in the arc by the decimal term .0174533, and that product by the radius.

Or, as the number of degrees in the circle (360) is to the number of degrees in the arc, so is the circumference of the circle to the length of the arc.

Or, from 8 times the chord of half the arc, subtract the chord of the whole arc, and divide the remainder by 3; this will be the length—nearly.

Or, from the square of the chord of half the arc, subtract the square of half the chord of the arc, the remainder will be the versed sine. Then proceed as above.

6. *To find the area of a sector of a circle.*

Rule.—Multiply the length of the arc by half the radius.

Or, as 360 is to the number of degrees in the arc, so is the area of the whole circle to the area of the sector.

7. *To find the area of a segment of a circle.*

Rule.—If less than a semi-circle, find the area of a sector having the same arc as the segment, and deduct therefrom the area of the triangle formed by the radii of the sector and the chord of the arc.

If greater than a semi-circle, find the area of the lesser portion of the circle by the above rule, and deduct it from the area of the whole circle.

8. *To find the area of a zone.*

Rule.—Deduct the sum of the areas of segments formed on the parallel sides of the zone from the area of the whole circle.

Or, to the area of the largest trapezium or parallelogram formed inside the zone, add the areas of the segment at each end of the parallelogram or trapezium.

9. *To find the area of a lune or crescent.*

Rule.—Find the areas of the two segments forming the lune, *the difference* will be the area required.

10. *To find the area of an ellipse.*

Rule.—Multiply its longest axis by its shortest, and its product by .7854.

11. *To find the circumference of an ellipse.*

Rule.—Square its two axes, and multiply the square root of half its sum by 3.1416.

12. *To find the area of an elliptic segment, cut off by a line perpendicular to either axis.*

Rule.—Find the area of a corresponding circular segment of equal altitude, and of same vertical axis or diameter. Then, as the vertical axis is to the one parallel with the base, so is the area of the circular segment to that of the elliptic segment.

Mensuration of Solids.

1. *To find the superficies or outside surface of a cylinder or prism.*

Rule.—Multiply the perimeter (distance around) of the base by the altitude, the product will be the lateral surface; then add to this the area of the bases or ends for the whole surface.

2. *To find the solid content of a cylinder or prism.*

Rule.—Multiply the area of the base by the height.

3. *To find the outside surface of a cube.*

Rule.—Add together the areas of the several sides. Or, multiply the girt, or perimeter of the figure by the length of the sides, and to the product add the area of the ends or bases.

4. *To find the solid content of a cube.*

Rule.—Multiply the area of the base by the height.

5. *To find the outside surface of a regular pyramid or of a cone.*

Rule.—Multiply the perimeter of the base by half the height of one side, and add the area of the base when required.

For a frustrum of a pyramid or cone, take half the sum of the perimeters of the the two ends by half the slant height.

6. *To find the solidity of a pyramid or cone.*

Rule.—Multiply the area of the base by one-third the perpendicular height.

7. *To find the solidity of a frustrum of a pyramid or cone.*

Rule.—To the area of the two ends add the square root of their product, and this multiplied by one-third the perpendicular height will give the solidity.

8. *To find the solidity of a wedge.*

Rule.—To the length of the edge add twice the length of the base; then multiply the *sum* by the height of the wedge, and the breadth of the base, and one-sixth of the product will be the solid contents.

9. *To find the solidity of a rectangular prismoid.*

Rule.—To the areas of the two ends add four times the area of the middle section, then multiply the sum by one-sixth of the height; the product will be the solidity.

The surface of a sphere is to the whole surface of a circumscribed cylinder, its bases included, as 2 is to 3, and the solidities of these bodies are in the same proportion.

10. *To find the surface of a sphere.*

Rule.—Multiply the circumference by the diameter, or multiply the square of the diameter by the decimal term 3·1416.

11. *To find the solidity of a sphere.*

Rule.—Multiply the cube of the diameter by the decimal ·5236.

12. *To find the surface of a spherical segment.*

Rule.—Multiply the whole circumference of the sphere, of which the segment is a portion, by the height of the segment.

13. *To find the solidity of a segment.*

Rule.—To three times the square of the radius of its base, add the square of its height, then multiply this sum by the height, and that product by the decimal ·5236.

Or, from three times the diameter of the whole sphere deduct twice the height of the segment, the remainder multiplied by the square of the height and the product by the decimal ·5236 will give the solidity.

14. *To find the surface of a ring.*

Rule.—Multiply half the sum of the outer and inner circumference by the girt.

15. *To find the solidity of a ring.*

Rule.—Multiply half the sum of its outer and inner circumference by the area of its cross section.

—— MEMORANDA ——
Concerning Various Materials.

Air. Specific gravity, 0·0012; weight of a cubic foot, 527 grains; 13·3 cubic feet of air will weigh 1 lb.

Ash. Specific gravity 0·76; weight of a cubic foot, 47·5 lbs; weight of a bar one foot long, and one inch square, 0·33 lbs.; will bear without permanent alteration a strain of 3,540 lbs. upon a square inch.

Atmosphere. The pressure of the atmosphere is nearly 15 lbs. upon a square inch, and is eqal to a column of water 34 ft. high.

Beech. Specific gravity, 0·696; weight of a cubic foot, 45·3 lbs.; will bear without permanent alteration on a square inch, a pressure of 2,360 lbs.

Brass, cast. Specific gravity, 8·37; a cubic foot weighs 523 lbs.; weight of a bar one foot long and one inch square, 3·63 lbs. melts at 1,869°; will bear on a square inch without permanent alteration, a pressure of 6,700 lbs.

Brick. Specific gravity, 1·841; weight of a cubic foot, 115 lbs., and will absorb about ¾ of a gallon of water; is crushed by a force of 562 lbs. upon a square inch.

Bridges. When an ordinary Road bridge is covered with people. it is about equivalent to a load of 120 lbs. to a square foot.

This may be safely calculated on as being the greatest load with which the bridge is likely to be covered , and one incapable of supporting such a load cannot be deemed safe.

Cast Iron. Specific gravity, 7·207; a cubic foot weighs 450 lbs. ; a bar one inch square and one foot long, weighs nearly 3·2 lbs. ; melts at 3,479○ ; and shrinks in cooling about $\frac{1}{8}$ of an inch for each foot in length; is crushed by a force of 93,000 lbs. upon a square inch, and will bear without permanent alteration 15,300 lbs. upon a square inch.

Coal, Newcastle. Specific gravity,, 1·269; weight of a cubic foot, 79·31 lbs. ; a bushel is generally rated at 84 lbs.

Copper. Specific gravity, 8·75; weight of a cubic foot, 549 lbs. ; weight of a bar one inch square and one foot long, 3·81 lbs. ; and melts at 2,548○ .

Earth, common. Specific gravity, 1·52 to 2·00; weight of a cubic foot, from 95 to 125 lbs. ; a cubic yard of common soil weighs about 3,429 lbs.

Granite. Specific gravity, 2·625; weight of a cubic foot, 164 lbs.; is crushed by a force of 10,900 lbs. upon a square inch.

Gravel. A cubic foot weighs about 120 lbs.

Gun Metal. (Copper 8 parts, tin 1 part) Specific gravity, 8·153; a cubic foot weighs 509½ lbs.; weight of a bar one foot long and one inch square, 3·54 lbs.; melts at 2,500○; and shrinks in cooling about one-sixth of an inch for each foot in length.

Horse-Power. The *unit* of nominal power for steam-engines, or the usual estimate of dynamical effect per minute of a horse, called, by engineers, *a horse-power*, is 33,000 lbs at a velocity of 1 foot per minute; or, the effect of a load of 200 lbs., raised by a horse for 8 hours a day, at the rate of 2½ miles per hour, or 150 lbs, at the rate of 220 feet per minute.

Lead, cast. Specific gravity, 11·353; a cubic foot weighs 709½ lbs.; weight of a bar one foot long and one inch square, 4·94 lbs. and melts at 612○.

Slate. Specific gravity, 2·752; weight of a cubic foot, 172 lbs.

Steel. Specific gravity, 7·84; weight of a cubic foot, 490 lbs.; welght of a bar one inch square and one foot long, 3·4 lbs.

Water, fresh. Specific gravity, 1·; a cu-

bic foot weighs 62½ lbs. ; weight of a gallon, 10 lbs. ; expands in freezing, about one-seventeenth of its bulk; and the expanding force of freezing water is about 35,000 lbs. upon a square inch.

Water, sea. Specific gravity, 1·0271; a cubic foot weighs 64·2 lbs.

Wind. Greatest observed velocity, 159 ft. per second; force of wind with that velocity, about 57¾ lbs. upon a square foot.

——NAILS.——

Number per pound of different Kinds and sizes.

3	penny,	fine,	1⅛	long,	720 in a pound.
3	"	common,	1¼	"	400 "
4	"	"	1½	"	300 "
5	"	"	1¾	"	200 "
6	"	"	2 in.	"	150 "
7	"	"	2¼	"	110 "
8	"	"	2½	"	85 "
9	"	"	2¾	"	75 "
10	"	"	3 in.	"	60 "
12	"	"	3¼	"	50 "
16	"	"	3½	"	40 "
20	"	"	4 in.	"	22 "
30	"	"	4½	"	16 "
40	"	"	5 in.	"	12 "

Table of Nails, continued.

50 penny, com. 5½ in. long, 10 in a lb.
60 " " 6 " 8 "

Casing Nails.

6	penny,	2	in. long.	220	in a pound.
8	"	2½	"	125	"
10	"	3	in. "	85	"
12	"	3¼	"	63	"

Fence Nails.

6	penny,	2	in. long,	80	in a pound.
8	"	2½	"	50	"
10	"	3	in. "	30	"

From 4½ to 5 lbs. of 4 penny nails, or 3 to 3½ lbs. of 3 penny nails will lay 1000 shingles. 5¾ lbs. of 3 penny fine lath nails will put on 1000 laths, joists being 16 inches to centers. 2½ lbs. of 8 penny common nails will lay a square of flooring of 5¼ in. matched boards, joists being 16 inches to centers. 2½ lbs. of 7 penny nails will put on a square of lap siding, showing 4 inches to the weather.

THE FRAMING SQUARE.

As a general rule, Carpenters are not thoroughly familiar with the *marks* on the Framing Square. To enumerate in detail, what *might* be accomplished with it, would require a good sized volume devoted exclusively to the subject.

Some of the following explanations may appear tedious to the advanced workman, but it is for those who need information that it is intended.

Let us now take up the "Eagle Square, No. 1" and see what we can find on it.

The Board Rule.

Across one side of the *Blade* at 12 inches, is laid down the following figures, commencing at the bottom: 8, 9, 10, 11, 12, 13, 14 and 15; these numbers represents the length in feet of the board to be measured, and also the number of feet in a board 12 inches wide. For any other width, as 8 inches, and the length 15 feet, opposite 8 in the space marked 15 is 10, the number of feet in the board. If the board is shorter, or longer than is given on the Square, take one-half or double the numbers.

The Brace rule.

On the *Tongue* of the Square, and on the same side that contains the board rule, is the *Brace rule*. The figures are laid down as follows: $\frac{24}{24}$ 33·9, $\frac{27}{27}$ 38·19 &c.

The double numbers represent the two sides of a square, and the decimal numbers are lengths of diagonals. Thus, if the two sides of a square are 24 each, the length for a brace will be 33 and 9 tenths; if the sides are 27, the brace will be 38 and 19 hundredths, and so on.

The Scale of Diagonals.

The Diagonal Scale is laid down at the end of the 'brace rule' near the corner of the Square, which consists of eleven equi-distant parallel lines, crossed by vertical ones, drawn obliquely, as follows:—

One inch is divided into ten equal parts above and below, and a line drawn from the top of the first perpendicular to the first division below, and continued parallel, by which method the first division on the second line from the top becoms 100th of an inch, and each of the others on the parallel lines one tenth.

The scale of hundredths reads downwards from the second parallel line where it intersects the first diagonal at the right-hand corner, this being 100th of an inch. The next space below is 200ths, the next 300ths, and so on to the last, which is 10 hundredths, or one-tenth of an inch.

The Octagon Rule.

On the other side of the Square along the *Tongue*, are a series of numbers: 10, 20, 30, 40, 50, and 60; which are five-twelvths of one-half as many inches, being the tangent of 22½° for circles whose diameters are 10 20, 30 &c. inches. These numbers are used as follows: We have a stick of timber 10 inches square, and wish to make it eight square; draw a center line on each side of the stick; set the dividers from the beginning of the Scale to 10, and set off this distance on each side of the line; this shows how much of the corner to take off.

The *Octagon Scale* is also on most of the Pocket Rules, given on two lines, marked M and E. The divisions on the line, M will be found to correspond with those on the Square, and are used in the same way.

The line, E, gives the distance from the *corner* of the stick to the angle of the octa-

gon, and is very convenient. Suppose you have a stick 6 inches square; set a *Guage* to 6, on the line, E, and guage this quantity each way from all the corners.

The lines, M, and E, can also be used for a *Brace Rule*; the line, E, being a table of of equal sides of a square, and M, a table of diagonals, or Braces.

Method of applying the Square On different kinds of work.

To lay out a Common Rafter.

A Roof is said to be a "quarter pitch" when the *rise* of the rafter is ¼ the width of the building; a *half*, or square pitch, when the rise is ½ the width, &c.

The figures, 6 and 12, (or any other proportionate numbers) will give the cuts for a quarter pitch; 8 and 12 for a third pitch; 12 and 12 for a half pitch; from which it will be observed that the rise per foot of the several pitches are, for a quarter pitch 6 inches; a third pitch 8 inches; a half pitch 12 inches. Other pitches are often used, as 3, 5, or 7 inches rise per foot. To get the *cuts* for those, use 3 and 12, 5 and 12, 7 and

12, or whatever it may be. To "lay out" a common rafter for, say a quarter pitch roof: suppose we begin at the *foot*, placing the figures, 6 and 12 on the outside edge of the Square even with the edge of the scantling and mark the long bevel from 12; this gives the "heel" cut which sets on the plate. To get the "plumb" cut for the outside edge of the plate, draw a line square from the heel, leaving at least one-half the width of the rafter solid over the plate.

To get the Length.

Extend the *plumb* cut to the edge of the scantling forming the *back*, or upper edge of the rafter. Set 12 against the end of this line, and 6 even with the back; then, with the Square in this position, space off as many lengths as there are feet in half-width of the Building, marking the top cut at the last space, using the bevel obtained at 6.

Should a fraction of a foot occur in half the width of the Building, lay out the last space in full for even feet; then slide the Square back on the *long* bevel until the inches on the Square at this bevel shall correspond with those of the width.

Some add 1½ inches to each foot of half width for a quarter pitch, but this makes

the rafter a trifle long, making but little difference on a short rafter, being about ½ inch too long for each 8 feet in length; a little practice with the Framing Square will soon be found more practicable than any other method.

HIP RAFTERS.

To get the *plumb* and *heel* cuts for a Hip, use the same figures for the rise that you do for the Common rafters of like pitch, but instead of taking 12 inches for the *run* take 17 —providing it is a *square* run; this number being the diagonal of a square, the sides being 12. Therefore, for a quarter pitch roof, 6 and 17, will be the bevels for the *heel* and *plumb* cuts. For any other pitch, use whatever the rise may be for a common rafter, but always take 17 for the run.

To get the Length of the Hip.

With the Square at 6 and 17 (for ¼ pitch) space off as many lengths as you would for common rafters on the same plan; thus, for a quarter-pitch Building 30 ft. square, the hips running to the center space off 15 times with the Square as above, viz: 6 and 17.

When the Hip is Out of Square.

Suppose you have a *rectangular* plan, say 16 × 24 ft. and want one or more hips run to the center. Halve each of the adjoining sides, and we have 8 ft. and 12 ft. respectively for *runs*. Let the total rise of the rafter be, say 6 ft. ; then the pitch on the 16 ft. side will be 6 ft. rise and 12 ft. run, and the 24 ft. side will be 6 ft. rise and 8 ft. run. Therefore, 6 and 12 will give the cuts for the *common* rafters on the *short* side, and 12 spaces with the square in this position will give the length; and 6 and 8,—or its equivalent 9 and 12—will give the cuts for the *common* rafter on the *long* side, and 8 spaces with the Square at 9 and 12 will give the length.

To get the Hips.

Measure the distance from 8 to 12 across the corner of the Square, and it gives 14½. Then, 6 and 14½ on the Square will give the cuts, and 12 spaces with the Square in this position will give the length.

It makes no difference with this method how much *run* there is *either* way; suppose you have 6 ft. run on one side, and 7½ ft. on the other; lay down the Square to 6 and

7½, and mark the *long* bevel; slide the Square along this line to 12, and the other side will be at 9⅝; measure across the corner of the Square from 9⅝ to 12, and it gives 15½. Then, the rise per foot of the 6 ft. run, with 15½ will give the cuts for the Hip, and 7½ spaces with the Square in this position will give the length.

Valley Rafters.

Valley rafters are obtained on the same principle as Hips of corresponding *rise* and *run*, the top being mitered from the center each way to fit the ridge or other rafters.

Jack Rafters.

To get the length of Jack rafters, take as many spaces with the Square as there are feet from the corner to where the jack sets, using the same figures that you do for common rafters of the same pitch.

To get the Side Bevel.

Measure the diagonal of the rise of one foot run of the common rafter, measuring across the Square from 6 to 12 (for a quarter pitch,) which will be nearly 13½ inches. Now lay down the Square to 12 and 13½,

the same as in laying out a miter, and use the *long* bevel. The *down* bevel will be the same as that of the common rafter.

Jack rafters should be got out in pairs, sawed true to the bevels, and numbered; the pair next the corner being No. 1.

If the preceding instructions are strictly adhered to, no difficulty need be anticipated as to their not being right

CRIPPLE STUDS.

Cripple studs vary in length in regular order for any pitch. If the roof is a quarter pitch, with studding 12 inches from centers, each stud would be 6 inches longer than its next shortest one, being a rise of 6 inches per foot. Where they are 16 inches from centers, first lay down the Square to 6 and 12, marking the side to 12; slide the Square along this line to 16, and on the tongue will be found the *rise*—8 inches, the difference in length of the studs.

To get the side bevel, use same figures as above, the lengths and bevels varying for the different pitches.

To get a Bevel for obtaining a Miter across the edge of a Bevelled piece.

Suppose you have a board ⅞ of an inch thick, and bevelled *on* ⅜ of an inch, and to a *feather-edge* at the back; the bevel for the miter will be obtained as follows:

Lay down the Square (the same as in laying out a rafter,) with the figures, 3 in. and 7 in. even with the edge of a straight board, and draw a line from 7 to the corner of the Square; slide the Square along this line to 12, and the other side will be at 5⅛; measure across the corner of the Square from 12 to 5⅛, and it gives about 13 inches; then, lay down the Square to 12 and 13, and set a bevel to the *short* line; this gives the miter across the bevelled edge.

For any other bevel than the one above given, proceed according to the following

General Rule.

Rule.—Take as many inches each way on the Square, as will correspond to the number of 8ths, 12ths, or 16ths that the piece is bevelled each way; or one-half the number or double the number, so that the ratio

of the numbers will not be changed; draw a line along either the *Tongue* or *Blade*, and slide the Square along this line until *either* side reaches 12 inches first; measure the *diagonal* from 12 to where the other side will be, and use this diagonal distance with 12, to get the miter,—using the *short* bevel.

To miter two Pieces together when both stand out of plumb, such as Splayed or Flaring Boxes, Hoppers &c.

First find the pitch that the sides and ends will stand on, viz: 3 inches per foot, 6 inches per foot, or whatever it may be.

Suppose the sides and ends of a box stand six inches *out of plumb* for each foot of perpendicular height; then, the diagonal of 6 and 12 ($13\frac{1}{2}$) will be the figures to use with 12 to get the miter, laying the Square across the *square edge* of the pieces, to 12 and $13\frac{1}{2}$, using the *short* bevel.

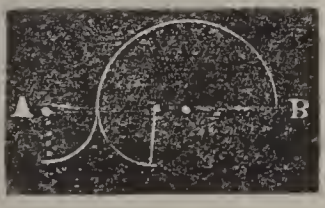
Where the edges of the pieces are to be bevelled, so as to be parallel with the base, a *square* miter will do; and also, by applying a *Try-Square* across this bevelled edge,

and then marking the pitch on both sides of the piece, a *butt-joint* will be obtained.

Where the sides form a different angle from the ends:—*To get the miter.*

First, get the miters for each pitch separately by the preceding methods, and draw them both across the edge of one of the pieces, the point of intersection forming an acute angle; bisect the angle thus formed, which will be the required miter.

HINTS ON SCROLL-DRAWING.



The art of SCROLL DRAWING when done with an ordinary pair of dividers, or compasses, consists merely in finding the right points to strike from, so that the change in the curvature of the arc will not be abrupt.

That a *true* taper-scroll cannot be drawn with the Compass is evident, as, in that case, the radius should be *constantly* changing; while, for ordinary purposes, the

Compass will be found far more convenient than anything else.

In the FIGURE on the preceding page, an elaborate design is dispensed with, as it would require such a great number of lines to show the several radii, that it would be more incomprehensible than a simple illustration, showing at a glance, the manner of obtaining a radius for any part of a circle.

Draw a line, A B, and from any point on this line, with any radius, describe a half-circle. If you wish to continue the curve with a less radius, take any *other* point on this line that will be nearer to the point you start from again. To turn the curve in an opposite direction, take any point on the line, A B, *outside* of the arc for a radius. A very good Scroll can be drawn by what is termed, "half circles drawn to centers" as follows:

First draw a straight line to work to, and on this line describe a half-circle. With a new radius on this line equal to one-half the former radius, describe another half circle opposite the first one; take a new radius again on this line equal to half the last radius; and so on, as far as you wish.

If it is required to draw another Scroll outside this one, so as to form a parallel distance between the two, use the same centers to strike from as at first, increasing the first radius to suit the required width.

With a little practice, a great variety of Scroll-work can be drawn with the Compasses. If a Scroll is commenced with a half-circle, it should be continued with half-circles; if begun with a quarter-circle, let the whole be composed of quarter-circles. In all attempts at Scroll-drawing with the Compasses, always bear this in mind:— *Draw a line from where you wish to end any part of an Arc, to the last center used, and take a new radius anywhere on that line.*

If you wish to change the direction outward, or opposite, extend the line through and beyond the arc, and take a new radius at any point on that line.

A continued PARALLEL SCROLL consisting of half-circles, can be drawn from two centers, on a given line. the distance between the *centers* being equal to the space between the lines of the Scroll; drawing each part only as far as the base line.

A very good TAPER SCROLL can be drawn as follows:— Describe a small

quarter-circle, and draw lines from each end of the arc through, and beyond the center described from. On either of those lines set back any distance, (the greater the distance between the centers, the more spread there will be to the Scroll,) and describe another quarter, drawing another line again from the last extremity of the arc through this last center. Set back on this line again, as far as on the previous one, and continue, by quarters, as far as desired.

REMEMBER, that these three points must always be in a direct line, viz: *The extreme end of the last Quarter Circle,—The last Center used,—And, the next Center to be used for a new radius.*

This is the whole secret of connecting Arcs of different radii, with the Compasses, and is something that every Mechanic can, and should be thoroughly familliar with.

On the following page, is given a method of tracing a Scroll with a string, and can be relied upon as being acurate. This is nothing new, but nevertheless, is of great importance where a *true* Scroll is required to be drawn.

A TRUE TAPER-SCROLL

Can be drawn by the following method: Make a Stock, or Center, in the form of an inverted cone, (A Boy's Spinning Top, for example,) and fasten to a board, or pattern by means of a long spur placed in the small end. Wind a string around the stock commencing at the large end. The end of the string should have a loop, in which to place a pencil; cut a groove around the point of the pencil, to allow the string to turn freely without slipping off; place the pencil in the loop, and commence to unwind the string from the Stock, until a Scroll of sufficient dimension is obtained.

Any form of Scroll may be produced, by varying the size, and form of the Stock around which the string is wound.

To trace a double line, by which a slot may be cut, it is only necessary, after describing the first curve, to turn the Stock a little, and repeat the operation, thus describing a second line parallel with the first one, and close to it.

A PARALLEL SCROLL

Can be drawn by using a Stock in the shape of a Cylinder, (a round stick,) for the string to be unwound from; even a *square* Stock, will give an approximate Scroll. A Scroll may be changed considerable, by the way in which the string is wound around the Stock,—either close, or extended. A little practice at such work occasionally during leasure hours, is absolutely necessary, so that the principles of operation, and the several modes of applying them, may be permanently fixed in the mind.

PROPORTIONS of MOULDINGS, PROJECTIONS, &c.

THE SCOTIA, OR COVE.

Divide the width and thickness into four equal parts each, and take three parts for a radius, to describe the quarter-circle that forms the cove.

THE HALF-ROUND.

When used in connection with the Scotia as cap, or a solid moulding, its width should be the same as that of the Scotia.

BEVEL FOR CASINGS.

The usual proportion for nearly all bevelled work, such as Door Casings, Base for Columns, Piazza skirting &c., is, to *Guage on* one-half the thickness of the material, and work to a feather-edge at the back.

PROJECTION OF CAPS.

The greatest projection beyond the Bed Moulding for Caps to Columns, Wainscoting, outside Door and Window Frames &c., ought not be less than the thickness of the Cap at its projecting edge.

Treads for Steps and Stairs, should only project one-half their thickness beyond the greatest projecting members under them.

PROJECTION OF CORNICES.

It is next to an impossibility to give any general rule to apply to the projections for Cornices, there being nearly as many different ideas in regard to it. as there are Builders.

For Dwelling Houses, a projection of 1½ inches per foot of height, from Sill to Plate, is the one now most in use.

The projection should be measured on a

line at right-angles to, or square from the Frieze to the outer edge of the Crown Moulding, both for the Eave and Rake.

This rule applies chiefly to two-story houses. Where the Building is only one story in height, the projection ought not be less than 2 inches per foot; except such minor appurtenances as, Piazzas, Bay Windows &c., which can be 1½ inches per foot.

WIDTH OF FRIEZE.

For an ordinary Frame dwelling, the Frieze may be from 12 to 15 inches wide for the Eave Cornice, the Rake Frieze conforming itself to that of the Eave, and varying in width according to the pitch of the roof.

The greatest width of plain Frieze for a Piazza may be from 8 to 10 inches, except when it is to be arched, in which case, it can be from 12 to 18 inches from the foot of the arch to the Planceer. Those are generally made of two members, called, the inside, and outside Frieze, (except when the Columns are made of one thickness of plank,) packed out with furring between them, and cased on the under side. This Casing, or under side of the Frieze is

termed the "Soffit" [pronounced, sof-feet.

The Soffit,—which includes the thickness of the inside and outside Frieze,— should be the same width as the Shaft, or body of the Columns.

The Frieze for a Bay Window may be 16 inches wide, having a Quarter-Round or other Moulding stuck on the lower edge where it laps on the Window Frame.

Wide, plain Friezes on *any* Cornice, should be suitably ornamented with panels or scroll-work of tasty design. "Mock Panels" are often made, by planting on some Half-Round Moulding, the ends of the panels being either square, octagonal, or pointed. The latter style is chiefly used on Gothic Buildings.

When Bracketts are to be used, instead of having the Frieze wide enough to receive them, it is often widened only where they are to be placed, showing a margin of five or six inches on each side of the Bracketts. In this case, it looks well to run an Architrave Moulding along the lower edge of the Frieze, breaking down, and around the *feet* of the Bracketts.

FRAMING.

The following Rules and explanations have been slightly abridged from "HATFIELD'S CARPENTER'S ASSISTANT"

"Before proceeding to consider the principles upon which a system of framing should be constructed, let us attend to a few of the Elementary laws in 'Mechanics', which will be found to be of great value in determining those principles.

LAWS OF PRESSURE.

"A heavy body always exerts a pressure equal to its own weight in a vertical direction. Thus,—suppose a weight, W, in FIG. 13, weighing 100 lbs., be suspended

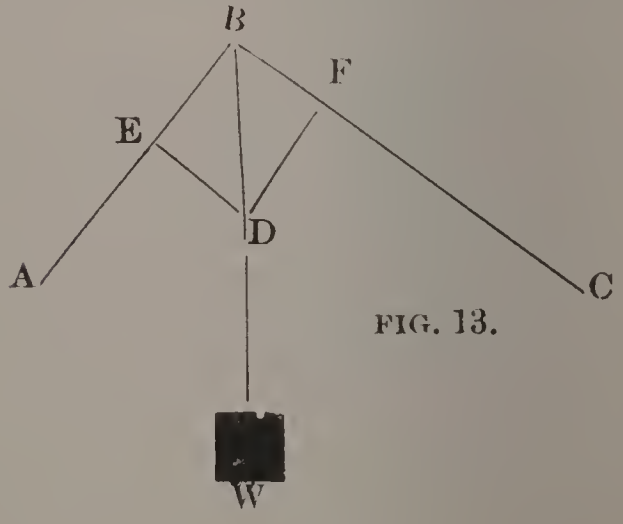


FIG. 13.

from an iron rod, D B, then, of course, the pressure exerted upon the rod, will be equal to that of the weight viz : 100 lbs. But if two inclined posts, A B, and B C, receives the strain, then, the united pressure upon these posts will be *more* than equal to the weight — being in proportion to their position; the farther apart their feet are placed, the greater will be the pressure, and *vice versa*. Hence, tremendous strains may be exerted by a comparatively small weight.

And it follows, therefore, that a piece of timber intended for a strut or post, should be so placed that its axis may coincide, as near as possible, with the direction of the pressure.

The direction of the pressure of the weight, W, is in the vertical line, D B, but, it exerts a proportionally greater pressure upon the oblique supports, A and C. It becomes important, therefore, to know the *exact* amount of pressure any certain weight is capable of exerting upon oblique supports. This can be ascertained by the following process :

"Let A B, and B C, FIG. 13, represent the axis of two sticks of timber supporting the weight, W ; and let the weight, W, be

equal to 6 tons. Make the vertical line, B D, equal to 6 inches; from D, draw D F parallel to A B, and draw D E, parallel to B C; then, the line, B E, will be found to be, say, 4 inches long, which is equal to the number of tons that the weight exerts upon the post, A B. The pressure upon the other post is represented by B F, which in this case, is supposed to measure 3 inches, representing 3 tons.

Thus it will be found that the weight, which weighs only 6 tons, exerts a pressure of 7 tons; the amount being increased because of the oblique position of the posts.

The lines, E B, B F, F D, and D E, comprise what is called the *parallelogram of forces*. The oblique strains exerted by any one force, therefore, may always be ascertained by making B D, equal (upon any scale of equal parts) to the number of lbs., cwts., or tons contained in the weight, W, and B E will then represent the number of lbs., cwts., or tons with which the timber, A B, is pressed, and B F, that exerted upon B C.

Correct ideas of the comparative pressure exerted upon timbers according to their position, will be readily formed by drawing various designs of framing, and

estimating the several strains in accordance with these principles.

The length of the timber used as posts, or struts, does not alter the amount of pressure; but it must be observed, that long timbers are not so capable of resistance as short ones.

"A beam laid horrizontally, supported at each end and uniformly loaded, is subject to the greatest strain at the middle of its length. The amount of pressure at that point is equal to half the whole load sustained. The greatest strain coming upon the middle of such a beam, mortises, large knots and other defects, should be kept as far as possible from that point; and, in resting a load upon a beam, as a partition upon a floor beam, the weight should be so adjusted that it will bear at or near the ends, by means of braces, trimmers &c.

The Resistance of Timber.

"When the stress that a given load exerts in any particular direction, has been ascertained, before the proper size of the timber can be determined for the resistance of that pressure, the strength of the

kind of timber to be used must be known.

The following rules for calculating the resistance of timber, are based upon the supposition that the timber used be *straight grained*, *seasoned*, and free from large knots splits, decay &c. The strength of a piece of timber, is to be considered in accordance with the direction in which the strain is applied upon it. When it is *compressed* in the direction of its *length*, its strength is termed the *resistance to compression*.

When the force tends to pull it asunder in the direction of its length, it is termed the *resistance to tension*. And when strained by a force tending to break it crosswise, its strength is termed the *resistance to cross strains*.

Resistance to Compression.

" When the height of a piece of timber exceeds about ten times its diameter if round, or ten times its thickness if rectangular, it will bend before crushing.

The following (Case I.) refers to such posts as would be *crushed* if overloaded, and the other two 'cases' to such as would *bend* before crushing. In estimating the strength of timber for this kind of resistance it is provided in the following rules that the

pressure be exactly in a line with the axis of the post.

"CASE I.— To find the area of a post that will safely bear a given weight, when the height of the post is less than 10 times its least thickness.

Rule.—Divide the given weight in pounds by 1000 for pine, or 1400 for oak, and the quotient will be the least area of the post in inches. This rule requires that the area of the *abutting* surface be equal to the result; should there be, therefore, a tenon on the end of the post, this quotient will be too small.

Example.— What should be the least area of a pine post that will safely sustain a load of 48,000 pounds?

48,000, divided by 1,000, gives 48—the required area in inches. Such a post may be 6×8 inches, and will bear to be of any length within 10 times 6 inches, its *least* thickness.

CASE II.— To find the area of a *rectangular* post that will safely bear a given load, when its height is 10 times its least thickness or *more*.

Rule.—Multiply the given weight or pressure in pounds, by the square of the length

in feet; and multiply this product by the decimal, ·0015 for oak, ·0021 for pitch pine, and ·0016 for white pine; then divide this product by the breadth in inches, and the cube root of the quotient will be the thickness in inches.

Example.— What should be the thickness of a pine post, 8 feet high, and 8 inches wide, in order to support a weight of 26,880 pounds? The square of the length is 64 feet; this, multiplied by the weight in pounds, gives 1,730,320; this product, multiplied by the decimal, ·0016 gives 2768·512; and this again, divided by the breadth in inches, gives 346·064; by reference to a table of cube-roots, the cube-root of this number will be 7, rejecting decimals. Therefore, the post should be, at least 7 × 8 inches square.

Case III.— To find the area of a *round*, or *cylindrical*, post, that will safely bear a given weight, when its height is ten times its least diameter, or *more*.

Rule.— Multiply the given weight or pressure in pounds by 1·7, and the product by ·0015 for oak, ·0021 for pitch pine, and ·0016 for white pine; then multiply the *square root* of this product by the height in feet, and the *square root* of the last product

will be the required diameter in inches.

Example.— What should be the diameter of a cylindrical oak post, 8 feet high, in order to support a weight of 26,880 pounds?

This weight in pounds, multiplied by 1·7 gives 45,696; and this, multiplied by the decimal, ·0015 gives 68,544; the square root of this product is 8·28, nearly; which, if multiplied by 8—the height of the post—gives 66·24; the square root of this number is 8·14, nearly; therefore, 8·14 inches is the diameter required.

Experiments have shown that the pressure should never be more than 1000 pounds per square inch on a joint in yellow pine, when the end of the grain of one piece is pressed against the side grain of the other.

Resistance to Tension.

"A bar of oak an inch square, pulled in the direction of its length, has been torn asunder by a force of ..... 11,500 pounds.

White pine.....	11,000	"
Pitch pine.....	10,000	"

Therefore, when the strain is applied in a line with the axis of the piece, the following rules must be observed:

To find the area of a piece of timber to resist a given strain in the direction of its length.

Rule.—Divide the given weight to be sustained, by the weight that will tear asunder a bar an inch square of the same kind of wood as above, and the quotient will be the area in inches that will just sustain the given weight; but, as a beam or post should never be strained or loaded to more than one fourth of its breaking weight, we must multiply the last area by 4.

Example.—What should be the area of a stick of pitch pine timber, which is required to sustain safely a constant load of sixty thousand pounds? This number, divided 10,000, gives 6, and this, multiplied by 4, gives 24 inches——the area, or a stick 4×6.

Resistance to Cross Strains.

To find the *Scantling* of a piece of timber to safely sustain a given weight, when such piece is supported at the ends in a horrizontal position.

Case I.— When the breadth is given.

Rule.—Multiply the square of the length in feet, by the weight in pounds, and this

product by the decimal, ·009 for oak, ·011 for white pine, and ·016 for pitch pine; divide the product by the breadth in inches, and the cube root of the quotient will be the depth required in inches.

Example.— What should be the depth of a beam of white pine, in order to support 900 lbs., having a bearing of 24 feet, and a depth of 6 inches?

The square of 24 is 576, and this, multiplied by 900, gives 518,400; and this again, by ·011 gives 5702·400; this, divided by 6, gives 950·400; the cube root of which is 9·83 inches, the depth required.

Case II,— When the depth is given.

Rule.—Multiply the square of the length in feet by the weight in pounds, and multiply this product by the decimal, ·009 for oak, ·011 for white pine, and ·016 for pitch pine; divide the last product by the cube of the depth in inches, and the quotient will be the breadth in inches required.

Example.— What should be the breadth of a beam of oak, having a bearing of 16 feet and a depth of 12 inches, in order to support a weight of 4000 lbs.? The square of 16 is 256, which, multiplied by 4000, gives 1,024,000; this, multiplied by ·009 gives 9216; and this again divided by 1728, — the

cube of 12.—gives $5\frac{1}{3}$ inches,—the breadth required.

NOTE. — The greater the depth of a beam in proportion to the thickness. The greater the strength, provided it be thoroughly stayed so as to prevent it from falling over and breaking sideways. A beam 3 × 16 inches square would bear twice as much as a square beam of the same section, which shows how important it is to make beams deep and thin.

TO CUT A RAKE CROWN MOULDING SO AS TO MITER WITH A PLUMB EAVE.

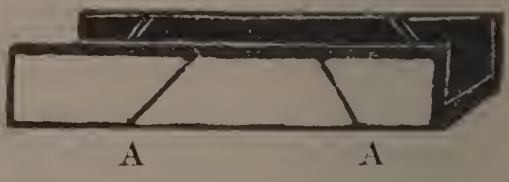


FIG. 14

Make the *plumb* cuts down the sides of the box as shown at A, A, FIG. 14, and cut the miter across the top as usual, but, remember, a *square* miter will not do. To get the bevel for the miter: proceed according to the method of getting the side bevel for Jack Rafters of same pitch roof. (See page 49, for side bevel of Jacks.) This rule applies to *any* pitch, by taking the pitch line of one foot run, and taking this with

12 to obtain the miter,—using the *long* bevel. The same bevel will also do for mitering Rake Facia and Frieze, or *any* raking member to a level one standing plumb.

To find the length of Rod, or distance between Tram Points for striking Segments.

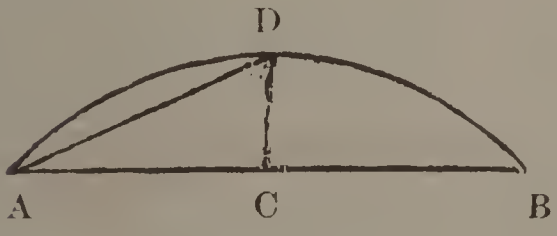


FIG. 15

The usual method among workmen is, after determining the three points A, B, and D, FIG. 15 to draw lines at right angles to, and from the center of each of the Chords of A D, and D B, taking the point of intersection of these lines for the radius. This is very well for small segments, but suppose you have a very large segment to strike, you will find it difficult to obtain the radius by *lines*, while with *figures* it becomes an easy task.

Suppose the Chord AD, to measure 25 inches, and the Versed sine CD, 8 inches; square the 25 inches (which is done by multiplying this number by itself) and then divide the product by the rise in inches, as 8.

DEMONSTRATION.

Let A D = 25
25
C D = 8)625 being the square of 25-
78⅛ inches, which would be the *diameter* of the circle, of which the arc, A D B, is a portion. Then, the *Radius*, or distance between the *Tram-points* would be one-half the diameter obtained.

Where feet and inches, or fractions of an inch occur in the measurements obtained at A D, or C D, both terms must be reduced to the lowest denomination contained in either of the measurements; thus, if A D, equals 25¼ inches, and C D, equal 6⅛ inches, then *each* term must be reduced to eighths before proceeding any farther; then, when the last result, or diameter, is obtained, it can be divided by 8, in order to bring it back to inches. The same result can be obtained more readily by reducing the fraction, to decimals.

Explanation of Arithmetical Signs generally used in Mathematical Calculations, to which particular attention should be given.

= Sign of equality, or equal to.
\+ " Addition, plus, or more.
— " Subtraction, minus, or less.
× " Multiplication.
÷ " Division.
: Is to.
:: So is. } Signs of Proportion.
: To.

$\surd$ Square root; when placed before a number, the square root is to be extracted, as, $\surd 64 = 8$.

$3\surd$ Cube root; and signifies that the cube, or third root is to be extracted, as $3\surd 64 = 4$.

A number is said to be *squared*, when it is multiplied by itself. To *cube* a number, is, to multiply it three times by itself, as, the cube of 4 is $4 \times 4 \times 4 = 64$.

○ Degrees, ′ minutes, ″ seconds.

In Duodecimals, ′ denotes *primes*, or twelfths, ″ *seconds*, or twelfths of primes, ‴ *thirds*, or twelfths of seconds; thus, the term, 4 6′ 3″ reads, 4 ft, 6 in. and 3 twlfths.

· Decimal point, as, .5 = five tenths, ·05 = five hundredths, 2·8 = 2 and 8 10ths.

THE CIRCLE; ITS RELATIVE PROPORTIONS, AREAS &C.

The diameter	of any circle*	x 3·1416	equals	the circumference.
" circumference	"	x ·31831	"	diameter.
" square of the diameter	"	x ·7854	"	area.
" " circumference	"	x ·07958	"	"
" circumference x ½ the radius			"	"
" √ of any (superficies		÷ ·7854)	"	diam. of circle of equal area.
" diameter of circle		x ·8862	"	side of an equal square.
" circumference "		x ·2881		
" " "		x ·2251		
" diameter "		x ·7071	"	side of an inscribed square.
" area "		x ·9003		
" side of any square		x 1·4142	"	diam. of circumscrib'g circle
" " "		x 4·443	"	circumference "
" " "		x 1·128	"	diam. of an equal circle.
" " "		x 3·545	"	circumference "
Square inches		x 1·273	"	round inches.
Circular inches		x ·00546	"	square feet.

The area of an inscribed square is always equal to one-half of the circumscribed square. [VOGDES] *multiplied by.

The Slide Rule.

The Slide Rule is a two-foot rule having only one joint, and is constructed as follows:

The line A is laid down twice along the top of the rule; the line C once in the same space at the bottom of the rule. Between them is a groove for the reception of the slide B C, which is merely a copy of the line A. There is a mutual relation between the lines which will be readily understood by attending to the remarks that follows.

When the slide B C, is laid evenly in the groove, that is, when the beginning of A coincides with the beginning of B, the numbers on A are the *same* as the numbers on B; when the slide is in *any other* position, the numbers on A are *proportional to* the numbers on B. The same is the case with the D line; when the slide lies evenly in the groove, the numbers on C, are the *squares* of those on D; and consequently, the numbers on D are the *square roots* of those on C. When the slide is in any other position, the numbers on C are *proportional to* the squares of those on D.

The values of the numbers on those lines are governed by the value set upon the first figure, and, being reckoned decimally

advance ten-fold. Thus, suppose 1 at the joint to be 1, then 1 at the middle of the rule is 10, and 10 at the end of the rule is 100; again, suppose 1 at the joint is 10, then 1 at the middle is 100, and 10 at the end is 1000; the intermediate divisions on which, complete the whole system of its notation.

Examples for practice.

To multiply numbers by the Rule.

Rule.—Set 1 on B opposite the multiplier on A, and against the number to be multiplied on B, is the product on A.

Example.— $2\frac{1}{2} \times 2\frac{1}{2}$ are how many?

Set 1 on B against $2\frac{1}{2}$ on A, and against $2\frac{1}{2}$ on B is $6\frac{1}{4}$ on A.

To divide numbers by the Rule.

Rule.—Set the divisor on B to 1 on A, and against the number to be divided on B, is the quotient on A.

Example.— Divide 9 by $2\frac{1}{4}$.

Set $2\frac{1}{4}$ on B against 1 on A, and against 9 on B is 4 (the quotient) on A.

Direct Proportion: By the Rule.

Rule.—Set the first term on B to the second on A, and against the third on B is the fourth on A.

Example.— 3 is to 5, as 6 is to what number?

Against 5 on A set 3 on B; against 6 on B is 10 (the answer) on A.

Inverse Proportion.

Rule.— Invert the Slide, and then the operation is the same as Direct proportion.

Example.— If 6 men can build a house in 12 days, how many could do the same work in 8 days?

Invert the Slide, and set 6 of C against 12 on A; against 8 on C is 9 on A.

Mensuration of Surfaces.

Rule.— When the length is given in feet, and the breadth in inches: Set the breadth on B against 12 on A, and against the length on A is the content in square feet on B.

Note.— If the dimensions are all inches, set the breadth on B against 144 on A, and against the length on A is the content in square feet on B.

Example.— How many feet in a board 14 inches wide and 14 feet long?

Set 14 of B against 12 on A, and against 14 on A is $16\frac{1}{3}$ on B.

Circles.

Set ·7854 of C against 10 on D; then C is a table of *areas*, and D a table of *diameters*. If 7 of B is set against 22 on A, then, A is a table of *circumferences*, opposite the diameters on B.

Solid Content of Round Timber.

Rule.— Measure the log around the middle, and call one-quarter of this the GIRT. Then set 12 of D to the length in feet on C, and against the *girt* in inches on D, is the solid content in feet on C.

The lines, M, and E, on the opposite side of the Rule are useful, either for laying out Octagons, or getting the length of Braces, fully explained on pages 44, 45.

With the Slide Rule, a great variety of operations may be performed, and, with a little practice, will soon be found to be of greater value than is generally supposed among Mechanics. Those Rules on which the D line commences with 1 are the best adapted to general use.

An Abridged, but Comprehensive System of Arithmetical Rules.

The following Rules and Memorandas are only intended to assist the memory of those who already understand the fundamental rules of common Arithmetic, and not for the new beginner; therefore all examples and demonstrations have been omitted.

Decimal Fractions.

Decimal fractions originate from dividing 1 into 10 equal parts, called *tenths*; each of these tenths is divided into 10 equal parts called *hundredths*; each of these hundredths is divided into 10 equal parts, called *thousandths;* and so on.

In writing Decimals, the denominator is omitted, and a point (.) called the *Decimal Point* ,is placed before the numerator separating it from the whole number (when the fraction is compound). Thus five and six tenths is written 5.6—and seventy five hundredths is written .75.&c.

Cyphers added to the *Right* hand of a decimal do not increase its value nor affect it in any way; but each cypher *prefixed* to a decimal fraction decreases its value tenfold.

Addition and Subtraction of Decimals.

Rule.— Place the numbers under each other according to their value; that is, tenths under tenths, hundredths under hundredths, &c., and proceed the same as in common addition and subtraction.

Multiplication of Decimals.

Write the numbers under each other as if they were *whole numbers*, and then proceed as in multiplication of simple numbers. Then point off in the product as many places for decimals as there are decimals in both factors. It may be sometimes necessary to prefix cyphers to the decimal part of the product, in order to have the number of decimal places equal to those of the two factors.

Division of Decimals.

Rule.—Proceed as in simple numbers, and point off in the quotient as many decimals as the number of decimal places in the dividend exceed those in the divisor, supplying any deficiency by prefixing cyphers to the left of the quotient.

To Reduce a Vulgar Fraction To a Decimal.

Rule.—Add to the numerator of the given fraction any number of cyphers at pleasure and divide the numerator by the denominator: then the quotient will be the decimal of equivalent value.

To find the Fractional Value Of a Decimal.

Rule.—Multiply the given decimal by the varions fractional denominations of the integer, or whole number, cutting off from the right hand of each product, for decimals, a number of figures equal to the given number of decimals, and thus proceed until the lowest degree is obtained.

DUODECIMALS,

Duodecimals are denominate numbers, the denominations of which increase according to the scale of 12.

The *foot* is the unit of measure. Each foot is divided into 12 equal parts called *primes*, each prime into 12 equal parts called *seconds*, and so on with the lower denominations, 1 being equal to 12 of the next lower denomination.

Multiplication of Duodecimals.

Rule.— Place units of the same value under each other, that is, feet under feet, inches under inches, &c. Begin at the right hand, multiplying each term of the multiplicand by the *lowest* denomination of the multiplier, reducing each product to the next higher term. Then take the next higher denomination of the multiplier and multiply each term of the multiplicand by that also, and so on, until the process will be completed; then add together the several products, carrying the *excess* of 12s from the right hand to the next higher term at the left.

Feet	× feet	gives	feet.
"	× inches	"	inches.
"	× twelfths	"	twelfths.
Inches	× inches	"	" or *seconds*.
"	× *seconds*	"	thirds.
Seconds	× "	"	fourths &c., &c.

Division of Duodecimals.

Rule.—First find out how many times the *highest* term of the divisor is contained in the *highest* term of the dividend; then multiply the *whole divisor* by this one term of the quotient, and subtract the product from the dividend. To the *result* bring down the next term of the dividend, and divide as before.

SIMPLE PROPORTION.

A Simple Proportion is an expression of equality between two simple and equal ratios. Thus, 3 : 4 :: 6 : 8 form a proportion. The terms are read, 3 is to 4 as 6 is to 8. The 1st and 4th terms are called the *Extremes;* the 2d and 3d, the *Means*. Thus, in the proportion given above, 3 and 8 are the *extremes*, and 4 and 6 the *means*.

In any Proportion. the product of the *means* is equal to the product of the *extremes*. Either *extreme* is equal to the product of the *means* divided by the other *extreme*. Either *mean* is equal to the product of the *extremes* divided by the other *mean*.

The fourth term of a proportion is equal to the third term divided by the *ratio* of the first to the second.

Rule.—I. Call the required answer, x, and write it in the *4th* place, and the term having the same *unit value*,(i.e. of like kind) in the *3d* place:

II. Then analyze the question, and see whether the *4th* term is greater or less than the *3d;* when greater. write the *least* of the remaining terms in the *1st* place, and when less. write the greater there. and the remaining term in the *2d* place.

III. Then multiply the *2nd* and *3rd* terms together, and divide the product by the *1st*.

Therefore, according to the preceding *Rules*, we have the following:

FORMULÆ.

Quantity : Quantity :: Cost : Cost.

Labor : Labor :: Time : Time.

Labor : Labor :: Work done : Work done.

If A : B :: C : D, then,

A*xD†=BxC. And B‡÷A=D÷C.

AxD÷B=C. And AxD÷C=B.

BxC÷D=A. And BxC÷A=D.

Thus, the terms BxC÷A=D; means that B multiplied by C and their *product* divided by A equals D.

FRACTIONS.

A fraction is composed of two terms, called the *Numerator* and *Denominator*.

Thus, ¾; 3 being the numerator, and 4 the denominator.

If both terms of a fraction be multiplied by the same number, its value wil not be changed.

---

*Multiplied by. †Equal to. ‡Divided by.

If both terms of a fraction be divided by the same number, the value of the fraction will not be changed.

To reduce a mixed number to an equivalent improper fraction.

Rule.—Multiply the whole number by the denominator; to the product add the numerator, and place the sum over the given denominator.

To reduce an improper fraction to an equivalent whole or mixed number.

Rule.—Divide the numerator by the denominator, and the quotient will be the equivalent whole or mixed number.

To reduce a fraction to its lowest terms.

Rule.—Divide the numerator and denominator, successively, by all their common factors: Or,

Divide the numerator and denominator by their greatest common divisor.

To reduce a compound fraction to a simple fraction.

Rule.—I. If there are mixed numbers, reduce them to improper fractions.

II. When there are common factors in the numerators and denominators, cancel them. Then, multiply the numerators together for a new numerator, and the denominators together for a new denominator

Curious and Useful Contractions.

To multiply any number of two figures by 11: Write the *sum* of the figures between them. Thus,—34x11=374.

Here we simply say, 3 and 4 are 7, and then place the 7 *between* the 3 and the 4.

N. B. When the *sum* of the figures is more than 9, increase the left-hand figure by the 1 to carry.

To square any number of 9s immediately without multiplying: Set down as many 9s less one (beginning at the left,) as there are 9s in the given number, an 8, as many 0s as you do 9s, and a 1.

To square any number ending in 5:

Omit the 5, and multiply the number as it will then stand, by the next higher number, and annex 25 to the product.

Thus. 35x35=1225: We simply say, 3 times 4 are 12, and annex the 25.

To square any number containing ½, as 5½ &c: Multiply the whole number by the next higher whole number, and annex ¼ to the product. Thus, 5½x5½=30¼. We simply say, '5 times 6 are 30' to which we add ¼.

To multiply any two like numbers together when the *sum* of the fractions is *one*.

Rule.—Multiply the whole number by the next higher whole number, and annex the *product* of the fractions. Thus,

$4\frac{3}{4}x4\frac{1}{4}=20$ and 3 16ths.

Rapid process of multiplying *all* mixed numbers.—This is a GENERAL RULE.

1st. Multiply the whole numbers together.
2nd. Multiply the upper whole number by the lower fraction.
3rd. Multiply lower whole number by the upper fraction.
4th. Multiply the fractions together.
5th. Add these *four* products together.

To multiply any two numbers together when the *sum* of the *unit* figures is *ten*, and the other figures of both factors are alike.

Thus.—47x43=2021.

We simply say 4 times 5 are 20, and 3 times 7 are 21, and set down each product successively.

By this, it will be observed, that we must always increase the upper *tens* figure 1 before multiplying.

To multiply any number by 125 add three ciphers, and divide by 8.

To multiply any number by $16\frac{2}{3}$ add two ciphers, and divide by 6.

To multiply any number by $33\frac{1}{3}$ add two ciphers and divide by 3.

To multiply any number by $166\frac{2}{3}$ add three ciphers, and divide by 6.

To multiply any number by $333\frac{1}{3}$ add three ciphers, and divide by 3.

To multiply any number by $6\frac{2}{3}$ add two ciphers, and divide by 15: or add one cipher and multiply by $\frac{2}{3}$.

To multiply any number by $66\frac{2}{3}$ add three ciphers, and divide by 15; or add two ciphers and multiply by $\frac{2}{3}$.

To multiply any number by $8\frac{1}{3}$ add two ciphers, and divide by 12.

To multiply any number by $83\frac{1}{3}$ add three ciphers, and divide by 12.

To multiply any number by $6\frac{1}{4}$ add two ciphers, and divide by 16 or its factors—4x4.

To multiply any number by $62\frac{1}{2}$ add three ciphers, and divide by 16.

To multiply any number by $18\frac{3}{4}$ add two ciphers, and multiply by 3, and divide by 16, or its factors, 4x4.

To multiply by $37\frac{1}{2}$ add two ciphers and multiply by 3, and divide by 8.

To multiply any number by 87½ add two ciphers, divide by 8, and subtract the quotient.

To multiply any number by 75 add two ciphers, divide by 4, and subtract the quotient.

To multiply by 99 add two ciphers, and subtract the given number from the result.

To multiply by any number of 9's.

RULE.—Annex as many ciphers to the multiplicand as there are 9's in the multiplier, and from this number subtract the number to be multiplied, and the remainder is the product required.

CROSS MULTIPLICATION.

Cross multiplication is a method of multiplying large numbers in a single line.

Here we multiply 5x4, set down the 0 and carry 2; next, 5x2 and 3x4 which, with the 2 to carry, gives 24, set down 4 and carry 2; last, 3x2 and add the 2 to carry, making 8.

24
35
——
840

Here we first multiply 7x4
2nd., 7x3 and 6x4. 3rd., 7x2, 5x4, and 6x3. 4th., 6x2 and 5x3.
5th and last, 5x2, carrying the excess of tens at each multiplication.

234
567
————
132678

MISCELLANEOUS MEMORANDAS PERTAINING TO MEASURES, CAPACITIES &c.

DISTILLED WATER.

One gal. = 10 lbs. = 277·75 cubic inches.

WINE MEASURE.

One gallon	=	231.	cubic inches.
One quart	=	57·75	" "
One pint	=	28·875	" "

DRY MEASURE.

One bushel	=	2150·42	cubic inches.
One gallon	=	268·80	" "
One quart	=	67·20	" "
One pint	=	33·60	" "

A heaping bushel of ears of corn, or roots, contains about 2,818 cubic inches.

BINS FOR GRAIN.

Knowing the number of bushels, to find the number of cubic feet which the bin must contain.

Increase the number of bushels one-fourth itself, and the result will show the number of cubic feet.

To find the number of bushels which a bin of given dimensions will hold.

Diminish the number of cubic feet in the bin by one-fifth, and the result will be content in bushels.

To find the number of cubic feet in a bin, or box. Multiply the length by the width, and that product by the depth.

Two cubic feet of good, sound, dry corn in the ear, will make a bushel of shelled corn.

Relative Weights of Metals.

Cubic inches multiplied by:

·263	= pounds of	cast iron.
·281	= "	wrought iron.
·283	= "	steel.
·3225	= "	copper.
·3037	= "	brass.
·26	= "	zinc.
·4103	= "	lead.
·2636	= "	tin.
·4908	= "	mercury.

Cylindrical inches multiplied by:

·2065	= "	cast iron.
·2168	= "	wrought iron.
·2223	= "	steel.
·2533	= "	copper.
·2385	= "	brass.
·2042	= "	zinc.
·3223	= "	lead.
·207	= "	tin.
·3854	= "	mercury.

Weight of Water at its Common Temperature.

1	cubic inch	=	·03617	lbs.
12	" inches	=	·434	"
1	" foot	=	62·5	"
1	" "	=	7·81	gallons.
1·6	" feet	=	100	lbs.
32	" "	=	1	ton.
1	cylindrical inch	=	·02842	lbs.
12	" inches	=	·341	"
1	" foot	=	49·1	"
1	" "	=	6·136	gallons.
2·036	" feet	=	100	lbs.
40·73	" "	=	1	ton.
12·5	gallons	=	100	lbs.
250	"	=	1	ton.

Bricklayer's Memoranda.

A load of mortar measures 1 cubic yard, or 27 cubic feet; requires 1 cubic yard of sand, and 9 bushels of lime; and will fill 30 hods.

A bricklayer's hod measuring 1 foot 4 inches x 9 inches x 9 inches; equals 1.296 cubic inches in capacity: and contains 20 bricks.

A single load of sand and other materials equals 1 cubic yard, or 27 cubic feet. And a double load equals twice that quantity.

ELEMENTS OF MACHINERY.

There are six simple machines, which are called *Mechanical powers*. They are the *Lever*, the *Pulley*, the *Wheel* and *Axle*, the *Inclined Plane*, the *Wedge*, and the *Screw*.

To understand the nature of a machine, four things must be considered.

1st The power or force which acts.

This consists in the efforts of men or horses, of weights, springs, steam, &c.

2d. The resistance which is to be overcome by the power. This generally is a weight to be moved.

3d. The center of motion, called a *fulcrum* or *prop*.

4th. The respective velocities of the power and resistance.

A machine is said to be in equilibrium when the resistance exactly balances the power.

THE LEVER.

An equilibrium is produced in any lever, when the weight, multiplied by the distance from the *fulcrum*, is equal to the power multiplied by the distance from fulcrum.

That is,

The weight is to the power, as the distance

from the power to the fulcrum, is to the distance from the weight to the fulcrum.

Hence, if A=weight; B=power;
C=distance from power to fulcrum;
and D=distance from weight to fulcrum;
Then, A : B :: C : D

THE PULLEY.

Pulleys are divided into two kinds, fixed pulleys and movable pulleys. When the pulley is fixed, it does not increase the power which is applied to raise the weight, but merely changes the direction in which it acts

A movable pulley gives a mechanical advantage. Thus a *weight* attached to a *single* movable pulley, having a cord passed around it, one end being fastened to a hook, and the hand or power at the other end, then, the hook will sustain one-half the weight, the hand sustains the other half.

It is plain, that in the movable pulley, all the parts of the cord will be equally stretched; and hence, each cord running from pulley to pulley, will bear an equal part of the weight; consequently,

Rule.—The power will always be equal to the weight divided by the number of cords which reach from pulley to pulley.

THE WINDLASS; OR WHEEL AND AXLE.

In order to balance the weight, we have the following:

Rule.—The power is to the weight, as the radius of the axle, is to the length of the crank, or radius of the wheel.

THE INCLINED PLANE.

Rule.—The power is to the weight, as the height of the plane is to its length.

THE WEDGE.

Rule.—Half the thickness of the head of the wedge, is to the length of one of its sides, as the power which acts against its head is to the effect produced at its side.

THE SCREW.

Rule.— As the distance between the threads of a screw, is to the circumference of the circle described by the power, so is the power employed to the weight raised.

LAWS OF FALLING BODIES.

A dense body falling vertically through a *vacuum*, falls 16 and one-twelfth feet during the first second, 48 and one-quarter feet during the second, 80 and five-twelfths feet the third second, and so on: the speed increasing at the rate of 32 and one-sixth feet for each second of time.

GENERAL RULES FOR CALCULATING THE SPEED AND DIAMETER OF PULLEYS.

PROBLEM 1ST.

The diameter of a pulley, and the speed it is required to run, with the speed of the shaft that is to drive it, given, to find the size of the driving pulley.

Rule.— Multiply the diameter of the pulley you have, by the speed that it is required to run, and divide this product by the speed of the shaft that is to drive it, the quotient will be the diameter required.

PROBLEM 2ND.

The diameter of two pulleys given, and the speed of one to find the speed of the other.

Rule.— Multiply the diameter of the pulley whose speed is given, by its number of revolutions per minute, and divide the product by the diameter of the pulley whose speed is not given, and the quotient will be the number of revolutions per minute.

Or, divide the greater diameter by the lesser diameter, and the quotient will be the number of revolutions the lesser will make, for one of the greater.

To Soften Putty and remove Paint.

To destroy paint on old doors &c., and to soften putty in old sash, so that the glass may be easily removed:— Take one part American Pearlash, and three parts of quick stone lime; slack the lime in water, then add the pearlash, making the mixture about the consistancy of paint.

Apply on both sides of the glass, or over the whole surface of old paint, letting it remain on 12 or 14 hours.

Quantity of Water in Pipes.

A pipe of one inch in diameter, and one yard in length, contains 28¼ cubic inches, or very nearly a pound or water.

Hence, the following practical rule is generally used to find the quantity of water in a pipe of any diameter.

Rule.—Square the diameter of the pipe in inches, the product will be the weight of water in pounds per yard of the pipe's length; shift the decimal point one place to the left, and the result is the quantity of water in a pipe of any given diameter per yard in gallons.

The content of any cylindrical vessel can be found in like manner.

Right and Left Hand Doors.

When standing at the opposite side from which the door is hung:—

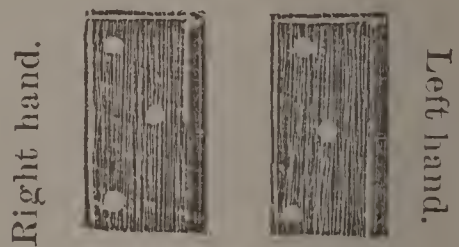
If it opens away from you to the right, it is said to be a *right-hand* door. If it opens away from you to the left, it is said to be a *left-hand* door.

LOOSE JOINT DOOR BUTTS.

TO TELL EITHER HAND AT A GLANCE.

Lay down the butts so that the knuckle-joint will be toward the right hand, thus:

A



Butts closed. B

Then, if they are open at the top, as at A they are *right hand*; if open at the bottom, as at B, they are *left hand*.

Doors are often affected by an unequal temperature of adjoining rooms, causing the *stiles* to spring, or warp; this may be remedied by using three hanging butts.

All doors 7 ft. or more in height, should be hung with three butts.

TABLE OF MEASURES.

A box 18x18 inches square, and 26⅛ inches deep, will contain a barrel; true content, 8467·20 cubic inches.

A hoop 18½ inches in diameter, and 8 inches deep will contain one bushel.

A box 15¼x15½ inches square, and 9¼ inches deep, will contain one bushel.

A box 10x12 inches square, and 9 inches deep, will contain half a bushel.

A box 8x8 inches square, and 8 inches deep, will contain one peck.

A box 8x8 inches square, and 4⅛ inches deep, will contain one gallon.

A box 4x8 inches square, and 4⅛ inches deep, will contain half a gallon.

A box 4x4 inches square, and 4¼ inches deep, will contain one quart.

A box 4x4 inches square, and 2⅛ inches deep, will contain one pint.

CUBIC, OR SOLID MEASURE.

1728 Cubic Inches..... 1 Cubic Foot.
27 Cubic Feet..... 1 Cubic Yard.
128 Cubic Feet..... 1 Cord.

SQUARE MEASURE.

144 Square Inches..... 1 Square Foot.
9 Square Feet..... 1 Square Yard.
100 Square Feet ... one Sq. of Flooring &c.

TINTS TO EXPRESS BUILDING MATERIALS:—As used by architects in draughting.

Materials.	*Color.*
Brickwork in plans and sections	Crimson lake.
Brickwork in elevations	Crimson lake mixed with burnt sienna or Venetian red.
The lighter woods, such as pine	Raw sienna.
Oak or ash	Vandyke brown.
Granite	Pale Indian ink.
Stone generally	Yellow ochre, or pale sepia.
Concrete works	Sepia with darker markings.
Wrought iron	Indigo.
Cast iron	Payne's grey or neutral tint.
Steel	Pale indigo tinged with lake.
Brass	Gamboge or Roman ochre.
Lead	Pale Indian ink tinged with indigo.
Clay or earth	Burnt umber.
Slate	Indigo and lake.

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